Far-Infrared Generation in Sb-Based Quantum Wells Pumped by Near-Infrared Diode Lasers

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Abstract

Intersubband transitions in semiconductor quantum wells (QWs) offer a variety of new possibilities for generating coherent electromagnetic waves in wavelength ranges that are inaccessible to conventional interband transitions. Among the wavelength ranges that are of current interest is the far-infrared (FIR), or terahertz (THz), range. While most intersubband generation schemes reported so far use well-explored AlGaAs-based QWs, Sb-based QWs offer several unique advantages, including large conduction band offsets that result in very deep QWs. Such deep QWs provide more design possibilities and flexibility, both in terms of the ranges of wavelength that can be generated, and in terms of the types of pumping sources that can be employed. In particular, they allow the use of readily available NIR diode lasers as pumping sources.

In this paper, we present results of our modeling and simulation of several Sb-based QWs including structures using AlSb or AlGaSb as barriers, and InAs, GaSb, or AlGaSb as wells. We first theoretically analyze the optical gain due to population inversion and Raman process in an optically pumped FIR laser based on a coupled triple-well structure. We also analyze FIR-generation based on a double-resonant difference frequency generation scheme. The results show that both schemes are very promising for generating coherent FIR radiation at room temperature. Based on our theoretical results we have grown several double and triple Sb-based quantum well structures, and characterization experiments are underway.

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